2006

Generalized Geologic Map for Land-Use Planning: Mercer County, Kentucky

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https://doi.org/10.13023/kgs.mc135.12
MAP AND CHART 135
Series XII, 2006

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Acknowledgments

Geology adapted from Carey and Hettinger (2000), Ciszak (2000a, b), Crawford (2004), Nelson (2000a, b), Sparks and Nuttall (2000), Thompson (2000), and Zhang (2000, 2004a, b). Sinkhole data from Paylor and others (2004). Karst illustration from Currens (2001). Pond construction illustrations courtesy of Paul Howell, U.S. Department of Agriculture, Natural Resources Conservation Service.

For Planning Use Only

This map is not intended to be used for selecting individual sites. Its purpose is to inform land-use planners, government officials, and the public in a general way about geologic bedrock conditions that affect the selection of sites for various purposes. The properties of thick soils may supersede those of the underlying bedrock and should be considered on a site-to-site basis. At any site, it is important to understand the characteristics of both the soils and the underlying rock. For further assistance, contact the Kentucky Geological Survey, 859.257.5500. For more information, and to make custom maps of your area, visit the KGS Land-Use Planning Internet Mapping Web Site at kgsmap.uky.edu/website/kyluplan/viewer.htm.

Mercer County Courthouse

Mercer County, 251 square miles in the Bluegrass Region of Kentucky, was formed in 1786. The population in 2004 was 21,493, a 3.2 percent higher population than in 2000. About 95 percent of Mercer countians have access to public water, and nearly 50 percent have access to sewer service. The bedrock of the county is 450 million -year-old limestone and shale of the Ordovician Period . Elevation in the county ranges from 483 feet at Lock 6 on the Kentucky River to 1,000 feet on a ridge just south of Ky. 152 about 2.5 miles east of the courthouse. Photo (location 9) by Dan Carey, Kentucky Geological Survey.

Bataan Memorial

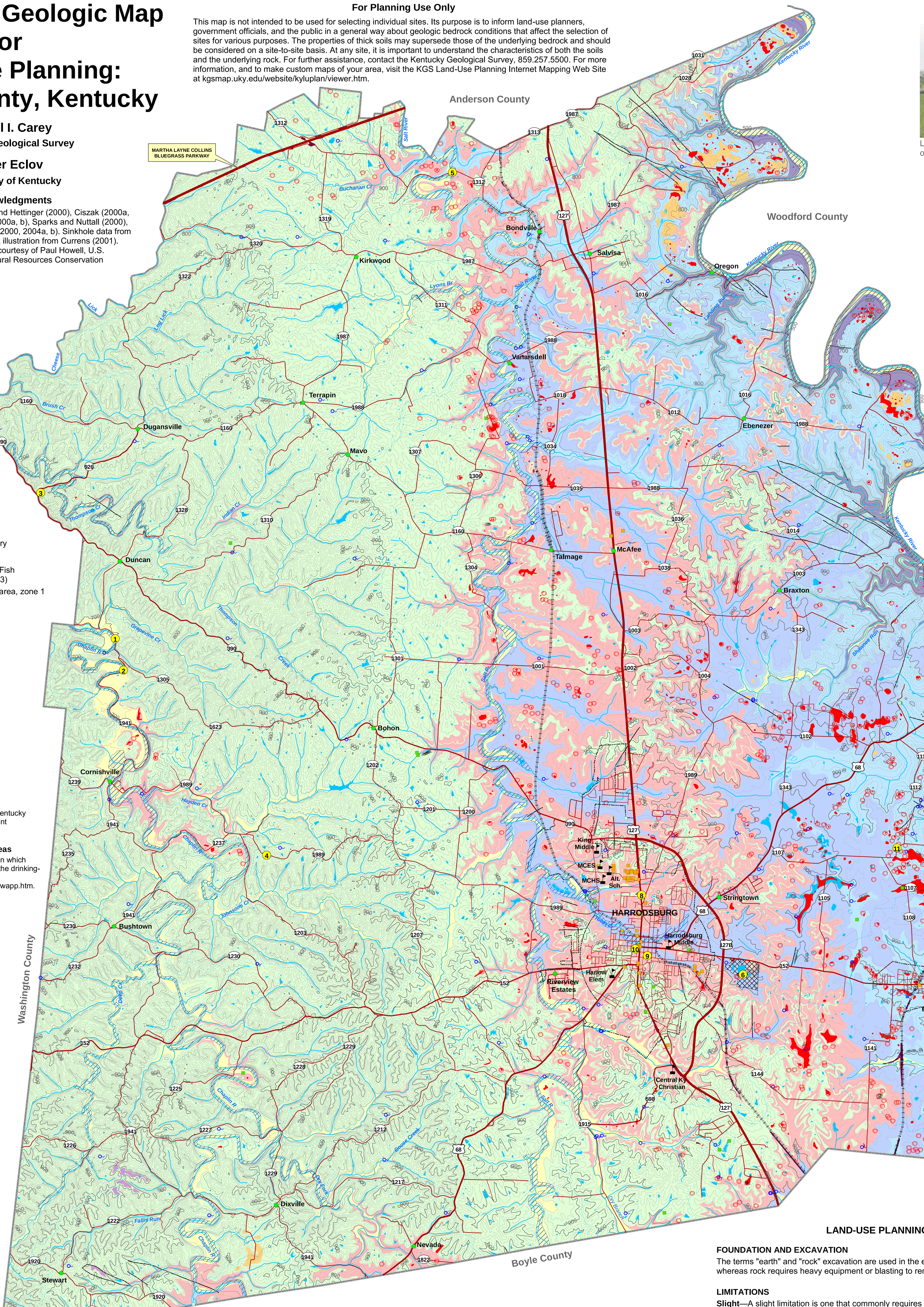
Sixty-six Mercer County men in Tank Battalion 192 fought at the World War II Battle of Bataan in the Philippines in 1942. Twenty-nine died in the battle. The remaining 37 survived the Bataan Death March and 3 years of POW camp to return home. This memorial on U.S. 127 north of Harrodsburg was erected in their honor. Photo (location 8) by Dan Carey, Kentucky Geological Survey.

Fort Harrod at Harrodsburg

In 1774, James Harrod established the first permanent settlement west of the Alleghenies. It is now a Kentucky state park and popular tourist attraction. More information is available at parks.ky.gov/stateparks/fh/. Photo (location 10) by Dan Carey, Kentucky Geological Survey.

Shakertown at Pleasant Hill

Two hundred years ago, the Shakers believed they were building heaven on earth here at Pleasant Hill; visitors in the springtime can understand why. The Centre Family Dwelling, shown here, was the largest of the 34 original buildings. Limestone from the nearby Kentucky River Palisades was used to construct the building in 1824–25. For more information, see www.shakervillageky.org. Photo (location 13) by Dan Carey, Kentucky Geological Survey.



EXPLANATION

- School
- Geologic fault
- Concealed geologic fault
- Railroad
- County line
- Incorporated city boundary
- Watershed boundary
- Wetlands > 1 acre (U.S. Fish and Wildlife Service, 2003)
- Source-water protection area, zone 1
- Quarry
- Mapped sinkholes
- Artificial fill

Water wells
- Domestic
- Monitoring
- Public
- Agricultural

- Severely eroded area
- Rock outcrop
- Sinkhole
- Wet area
- Mine or quarry
- Spring

20-foot contour interval

(4) Photo location

*Flood information is available from the Kentucky Division of Water, Flood Plain Management Branch, www.water.ky.gov/floods/.

Source-Water Protection Areas

Source-water protection areas are those in which activities are likely to affect the quality of the drinking-water source. For more information, see kgsweb.uky.edu/download/water/swapp/swapp.htm.

N

Scale = 1: 48,000   1 inch equals 3/4 mile

0 0.5 1 2 3 4 Miles

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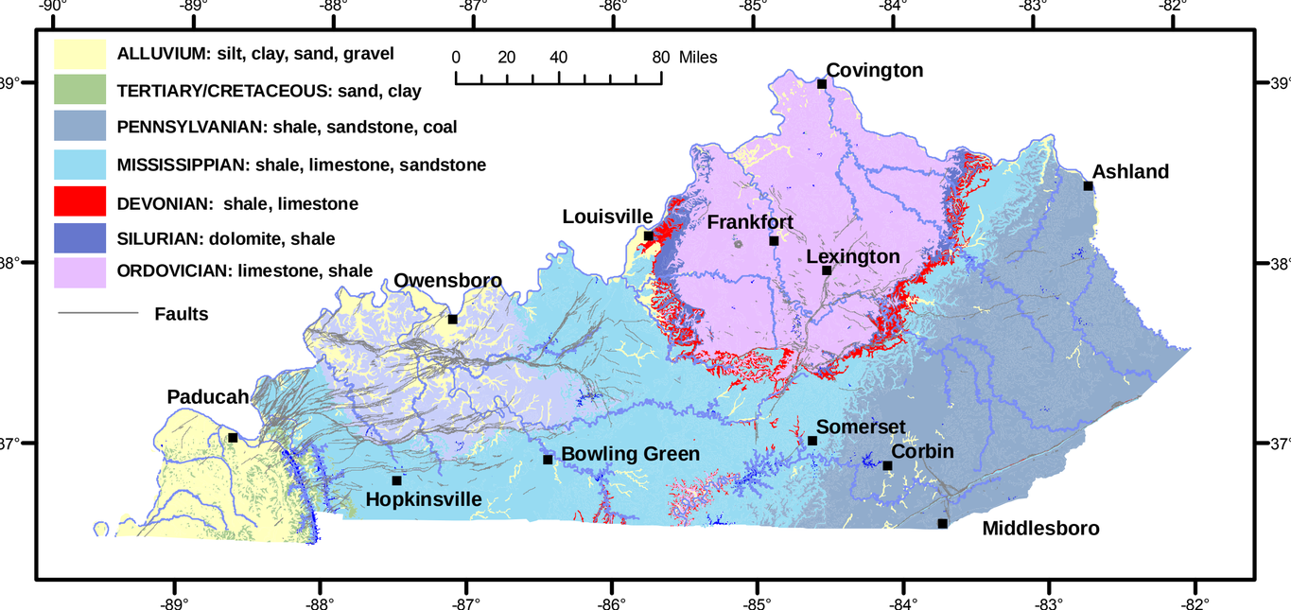
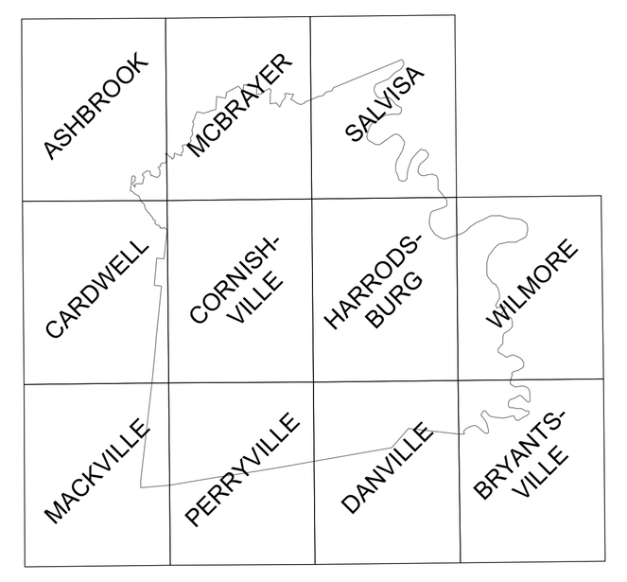
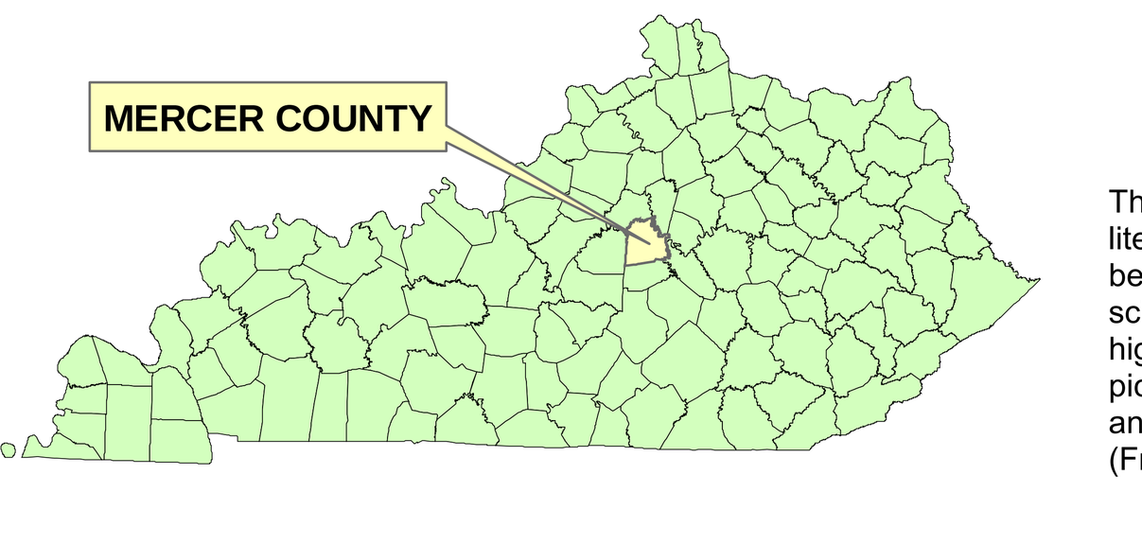
Geology of Kentucky



Learn more about Kentucky geology at www.uky.edu/KGS/geoky/

7.5-Minute Quadrangle Map Index





Additional Resources

Listed below are Web sites for several agencies and organizations that may be of assistance with land-use planning issues in Mercer County:

ces.ca.uky.edu/Mercer/ University of Kentucky Cooperative Extension Service
www.bgadd.org/ Bluegrass Area Development District
www.thinkkentucky.com/edis/cmnty/cw068/ Kentucky Economic Development Information System
www.uky.edu/KentuckyAtlas/21167.html Kentucky Atlas and Gazetteer, Mercer County
quickfacts.census.gov/qfd/states/21/21167.html U.S. Census data
kgsweb.uky.edu/download/kgsplanning.htm Planning information from the Kentucky Geological Survey

Radon

Radon gas can be a local problem, although it is not widely distributed in Kentucky in amounts above the U.S. Environmental Protection Agency's maximum recommended limit of 4 picocuries per liter. Unit 4 on the map, the Tanglewood Limestone, may contain high levels of uranium or radium, parent materials for radon gas. The Tanglewood and several other limestones in the state contain apatite, a phosphate mineral. Uranium is sometimes part of the apatite crystal structure, and when the limestone weathers away the phosphates containing uranium can become concentrated in the soil and ultimately give rise to high levels of radon. A few areas of high radon concentrations have been recorded in the Bluegrass Region. Homes in these areas should be tested for radon, but the homeowner should keep in mind that the threat to health results from relatively high levels of exposure over long periods, and the remedy may simply be additional ventilation of the home.

COMPARATIVE RISK CHART for RADON LEVELS

Radon Level pCi/L	Estimated Fatal Lung Cancers/1000	Comparable Exposure Levels	Comparable Risk Estimate
200	440 - 770	1,000 times average outdoor level	More than 60 times non-smoker risk
100	270 - 630	100 times average outdoor level	Four pack/day smoker or 20,000 chest X-rays/yr
40	120 - 380	100 times average outdoor level	Two-pack/day smoker
20	60 - 210		
10	30 - 120	10 times average indoor level	One pack/day smoker
4	13 - 50	10 times average outdoor level	Five times non-smoker risk
2	7 - 30		
1	3 - 13	Average indoor level	Non-smoker risk of fatal lung cancer
0.2	1 - 3	Average outdoor level	20 chest X-rays/yr

The EPA recommends action be taken if indoor levels exceed 4 picocuries per liter, which is 10 times the average outdoor level. Some EPA representatives believe the action level should be lowered to 2 picocuries per liter; other scientists dissent and claim the risks estimated in this chart are already much too high for low levels of radon. The action level in European countries is set at 10 picocuries per liter. Note that this chart is only one estimate; it is not based upon any scientific result from a study of a large population meeting the listed criteria. (From the U.S. Environmental Protection Agency.)

LAND-USE PLANNING TABLE DEFINITIONS

FOUNDATION AND EXCAVATION

The terms "earth" and "rock" excavation are used in the engineering sense; earth can be excavated by hand tools, whereas rock requires heavy equipment or blasting to remove.

LIMITATIONS

Slight—A slight limitation is one that commonly requires some corrective measure but can be overcome without a great deal of difficulty or expense.

Moderate—A moderate limitation is one that can normally be overcome but the difficulty and expense are great enough that completing the project is commonly a question of feasibility.

Severe—A severe limitation is one that is difficult to overcome and commonly is not feasible because of the expense involved.

LAND USES

Septic tank disposal system—A septic tank disposal system consists of a septic tank and a filter field. The filter field is a subsurface tile system laid in such a way that effluent from the septic tank is distributed with reasonable uniformity into the soil.

Residences—Ratings are made for residences with basements because the degree of limitation is dependent upon ease and required depth of excavation. For example, excavation in limestone has greater limitation than excavation in shale for a house with a basement.

Highways and streets—Refers to paved roads in which cuts and fills are made in hilly topography, and considerable work is done preparing subgrades and bases before the surface is applied.

Access roads—These are low-cost roads, driveways, etc., usually surfaced with crushed stone or a thin layer of blacktop. A minimum of cuts and fills are made, little work is done preparing a subgrade, and generally only a thin base is used. The degree of limitation is based on year-around use and would be less severe if not used during the winter and early spring. Some types of recreation areas would not be used during these seasons.

Light industry and malls—Ratings are based on developments having structures or equivalent load limit requirements of three stories or less, and large paved areas for parking lots. Structures with greater load limit requirements would normally need footings in solid rock, and the rock would need to be core drilled to determine the presence of caverns, cracks, etc.

Intensive recreation—Athletic fields, stadiums, etc.

Extensive recreation—Camp sites, picnic areas, parks, etc.

Reservoir areas—The floor of the area where the water is impounded. Ratings are based on the permeability of the rock.

Reservoir embankments—The rocks are rated on limitations for embankment material.

Underground utilities—Included in this group are sanitary sewers, storm sewers, water mains, and other pipes that require fairly deep trenches.

For information on obtaining copies of this map and other Kentucky Geological Survey maps and publications call our Public Information Center at 859.257.3896 or 877.778.7827 (toll free)

View the KGS World Wide Web site at: www.uky.edu/kgs

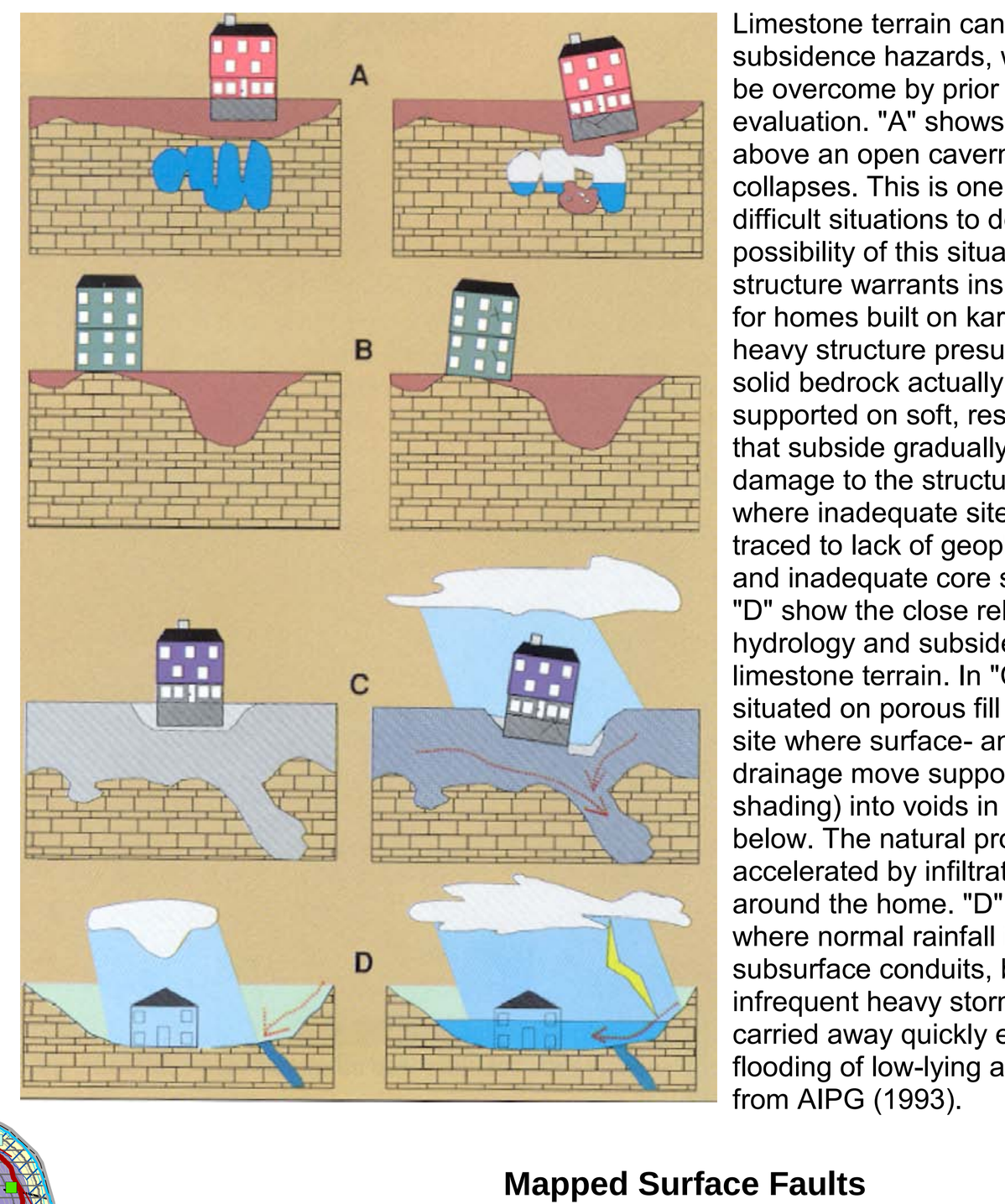
Competing Land Uses

Limestone terrain provides fertile soils for agriculture and pleasing sites for rural residential development. Thoughtful planning can balance the needs of both interests. Photo (location 11) by Dan Carey, Kentucky Geological Survey.

Rural Residential Development

Rural residential development near Ky. 152 east of Burgin. Photo (location 12) by Dan Carey, Kentucky Geological Survey.

Karst Subsidence



Limestone terrain can be subject to subsidence hazards, which usually can be overcome by prior planning and site evaluation. "A" shows construction above an open cavern, which later collapses. This is one of the most difficult situations to detect, and the possibility of this situation beneath a structure warrants insurance protection for homes built on karst terrain. In "B," a heavy structure presumed to lie above solid bedrock actually is partially supported on soft, residual clay soils that subside gradually, resulting in damage to the structure. This occurs where inadequate site evaluation can be traced to lack of geophysical studies and inadequate core sampling. "C" and "D" show the close relationship between hydrology and subsidence hazards in limestone terrain. In "C," the house is situated on porous fill (light shading) at a site where surface- and groundwater drainage move supporting soil (darker shading) into voids in limestone (blocks) below. The natural process is then accelerated by infiltration through fill around the home. "D" shows a karst site where normal rainfall is absorbed by subsurface conduits, but water from infrequent heavy storms cannot be carried away quickly enough to prevent flooding of low-lying areas. Adapted from AIPG (1993).

Mapped Surface Faults

Faults are common geologic structures across Kentucky, and have been mapped in many of the Commonwealth's counties. The faults shown on this map represent seismic activity that occurred several million years ago at the latest. There has been no activity along these faults in recorded history. Seismic risk associated with these faults is very low. Faults may be associated with increased fracturing of bedrock in the immediately adjacent area. This fracturing may influence slope stability and groundwater flow in these limited areas.

Shale and Limestone

Limestone and shale underlie all of Mercer County. In general, the shale content of the bedrock increases from east to west across the county and the land becomes more rugged. Ponds are common in shalier areas. Photo (location 4) by Dan Carey, Kentucky Geological Survey.

Unit 7 Topography

Rolling hills underlain by shale and limestone (unit 7) in western Mercer County. Photo (location 3) by Dan Carey, Kentucky Geological Survey.

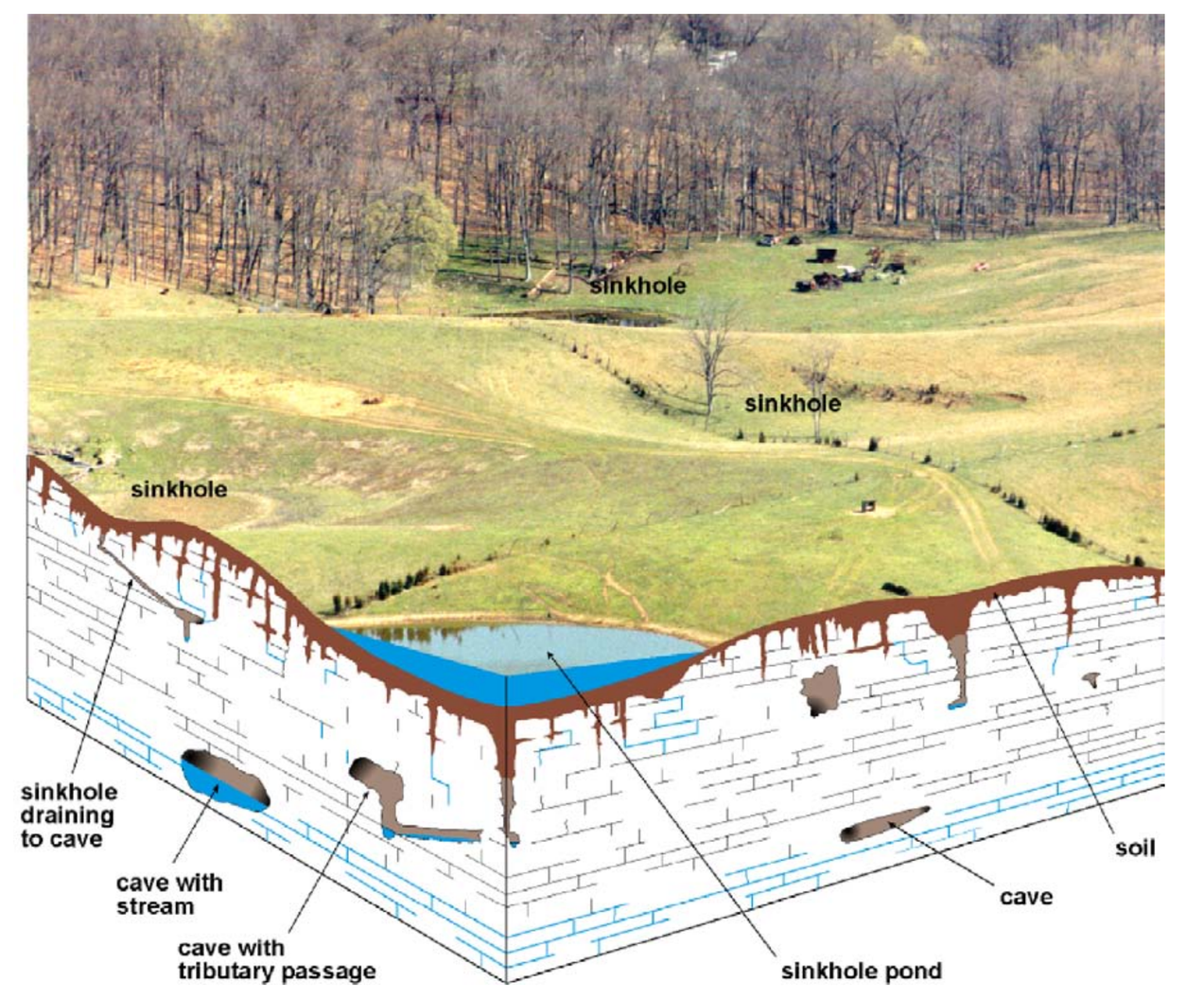
Chaplin River Alluvium

Alluvium along major streams provides soils for agriculture. The Chaplin River bottomland north of Cornishville is especially broad. Photo (location 2) by Dan Carey, Kentucky Geological Survey.

Karst Geology

Karst areas (units 3 to 6) are indicated by sinkholes and are generally along and to the east of the Salt River. The term "karst" refers to a landscape characterized by sinkholes, springs, sinking streams (streams that disappear underground), and underground drainage through solution-enlarged conduits or caves. Karst landscapes form when slightly acidic water from rain and snowmelt seeps through soil cover into fractured and soluble bedrock (usually limestone, dolomite, or gypsum). Sinkholes are depressions on the land surface into which water drains underground. Usually circular and often funnel-shaped, they range in size from a few feet to hundreds of feet in diameter. Springs occur when water emerges from underground to become surface water. Caves are solution-enlarged fractures or conduits large enough for a person to enter.

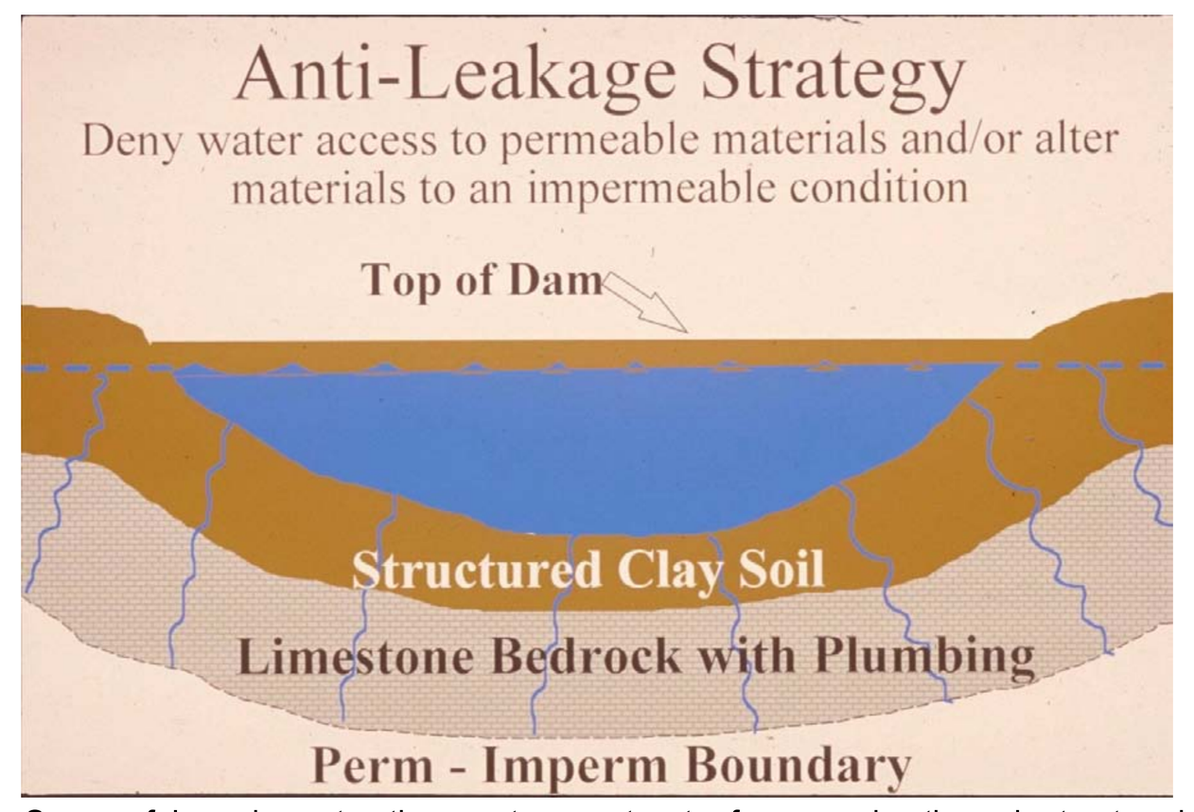
Environmental Protection



- Never use sinkholes as dumps. All waste, but especially pesticides, paints, household chemicals, automobile batteries, and used motor oil, should be taken to an appropriate recycling center or landfill.
- Make sure runoff from parking lots, streets, and other urban areas is routed through a detention basin and sediment trap to filter it before it flows into a sinkhole.
- Make sure your home septic system is working properly and that it's not discharging sewage into a crevice or sinkhole.
- Keep cattle and other livestock out of sinkholes and sinking streams. There are other methods of providing water to livestock.
- See to it that sinkholes near or in crop fields are bordered with trees, shrubs, or grass buffer strips. This will filter runoff flowing into sinkholes and also keep tilled areas away from sinkholes.
- Construct waste-holding lagoons in karst areas carefully, to prevent the bottom of the lagoon from collapsing, which would result in a catastrophic emptying of waste into the groundwater.
- If required, develop a groundwater protection plan (410KAR5:037) or an agricultural water-quality plan (KRS224.71) for your land use.

(From Currens, 2001)

Pond Construction



Successful pond construction must prevent water from seeping through structured soils into limestone solution channels below. A compacted clay liner or artificial liner may prevent pond failure. Getting the basin filled with water as soon as possible after construction prevents drying and cracking, and possible leakage, of the clayey soil liner. Ponds constructed in dry weather are more apt to leak than ponds constructed in wet weather. A geotechnical engineer or geologist should be consulted regarding the requirements of a specific site. Other leakage prevention measures include synthetic liners, bentonite, and asphaltic emulsions. The U.S. Department of Agriculture–Natural Resources Conservation Service can provide guidance on the application of these liners to new construction, and for treatment of existing leaking ponds.

Dams should be constructed of compacted clayey soils at slopes flatter than 3 units horizontal to 1 unit vertical. Ponds with dam heights exceeding 25 feet, or pond volumes exceeding 50 acre-feet, require permits. Contact the Kentucky Division of Water, 14 Reilly Rd., Frankfort, KY 40601, telephone: 502.564.3410. Illustration by Paul Howell, U.S. Department of Agriculture–Natural Resources Conservation Service.

Groundwater

In the bottoms of the Salt, Dix, and Kentucky Rivers, most drilled wells will produce enough water for a domestic supply at depths of less than 100 feet. In the larger creek and river valleys, and a limited area between Harrodsburg and Shaker Village of Pleasant Hill, wells will produce enough water for a domestic supply, except during dry weather. In upland areas (65 percent of the county), most drilled wells will not produce enough water for a dependable domestic supply. Some wells along drainage lines may produce enough water, except during dry weather. Throughout the county, groundwater is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet. For more information on groundwater in the county, see Carey and Stickney (2004).

Water Resources

Mercer County is blessed with an abundance of water. Average annual rainfall is 46 inches. The Kentucky and Dix Rivers form the eastern boundary of the county. The Salt River bisects the county, and the Chaplin River flows near the western border. All flow from south to north.

Kentucky River

Limestone that forms the Kentucky River Palisades was used by early settlers for building material. Photo (location 14) by Dan Carey, Kentucky Geological Survey.

Herrington Lake

Herrington Lake was created by damming the Dix River in the mid-1920's. The dam was built for hydroelectric power generation and flood protection. Kentucky Utilities owns the dam and the associated E.W. Brown Power Generating Station. The 2,335-acre lake now provides fishing, water sports, camping, and residential living opportunities. As the karst area around the lake is developed, it is imperative that properly functioning onsite wastewater treatment facilities be installed and maintained to prevent pollution of the lake. Aerial photo (2004, location 7) by the U.S. Department of Agriculture, Farm Services Administration, National Agricultural Imagery Program.

Salt River

The Salt River bisects Mercer County from north to south. Shale and limestone of unit 7 are dominant to the west of the river; karstic limestones dominant to the east. Photo (location 5) by Dan Carey, Kentucky Geological Survey.

Chaplin River

The beautiful Chaplin River sparkles in the springtime sun. Photo (location 1) by Dan Carey, Kentucky Geological Survey.

Mineral Resources

Mercer Stone excavates limestone from unit 4 in a quarry near the U.S. 127 Bypass east of Harrodsburg, and provides a variety of limestone aggregate products. Photo (2004, location 6) by the U.S. Department of Agriculture, Farm Services Administration, National Agricultural Imagery Program.

Planning Guidance by Rock Unit Type

Rock Unit	Foundation and Excavation	Septic System	Residence with Basement	Highways and Streets	Access Roads	Light Industry and Malls	Intensive Recreation	Extensive Recreation	Reservoir Areas	Reservoir Embankments	Underground Utilities
1. Silt, sand, and gravel	Fair foundation material; easy to excavate. Seasonal high water table. Subject to flooding.	Severe limitations. Seasonal high water table subject to flooding. Refer to soil report (Craddock, 1983).	Water in alluvium may be in direct contact with basements. Seasonal high water table subject to flooding. Refer to soil report (Craddock, 1983).	Slight limitations. Refer to soil report (Craddock, 1983).	Slight limitations. Refer to soil report (Craddock, 1983).	Moderate to slight limitations. Avoid construction in floodplain. Refer to soil report (Craddock, 1983).	No limitations. Possible flooding. Refer to soil report (Craddock, 1983).	No limitations. Possible flooding. Refer to soil report (Craddock, 1983).	Pervious material. Seasonal high water table. Subject to flooding. Refer to soil report (Craddock, 1983).	Fair stability. Fair compaction. Piping hazard. Refer to soil report (Craddock, 1983).	Slight limitations. Seasonal high water table. Refer to soil report (Craddock, 1983).
2. Silt, sand, and gravel (terrace deposits)	Good foundation material; easy to excavate.	Severe to moderate limitations. Possible groundwater contamination.	Slight limitations.	No limitations.	No limitations.	No limitations.	No limitations.	Moderate to slight limitations. Steep wooded slopes. Potential for forest reserve or natural history park.	Not applicable.	Not applicable.	Slight limitations.
3. Limestone	Excellent foundation material; difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures; danger of groundwater contamination.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Sinks common; drainage required.	Slight to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Sinks common; local drainage problems.	Moderate limitations. Rock excavation. Steep slopes; narrow ravines. Slight limitations where topographically suitable.	Slight to moderate limitations, depending on topography. Rock excavation; locally, upper few feet may be rippable. Sinks common; local drainage problems.	No limitations.	Moderate to slight limitations. Steep wooded slopes. Potential for forest reserve or natural history park.	Severe limitations. Leaky reservoir rock; locally, conditions may be favorable. Sinks common.	Severe limitations.	Severe limitations. Rock excavation.
4. Limestone, evenly bedded	Excellent foundation material; difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures; danger of groundwater contamination.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Solution channels common; local seepage problems.	Slight to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Solution channels common; local seepage problems.	Slight limitations. Local drainage problems.	Slight to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Solution channels; local seepage problems.	No limitations.	No limitations.	Severe to moderate limitations. Leaky reservoir rock; locally, conditions may be favorable. Solution channels common.	Severe limitations.	Severe limitations. Rock excavation.
5. Limestone, irregularly bedded	Excellent foundation material; difficult to excavate.	Severe limitations. Impermeable rock. Locally fast drainage through fractures; danger of groundwater contamination.	Severe to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Sinks common; drainage required.	Slight to moderate limitations. Rock excavation; locally, upper few feet may be rippable. Sinks common; local drainage problems.	Slight limitations. Local drainage problems from seeps or springs; sinks common.	Slight to moderate limitations, depending on topography. Rock excavation; locally, upper few feet may be rippable. Sinks common; local drainage problems.	No limitations.	No limitations.	Severe limitations. Leaky reservoir rock; locally, conditions may be favorable. Sinks common.	Severe limitations.	Severe limitations. Rock excavation.
6. Limestone and shale	Good to excellent foundation material; difficult excavation.	Severe to moderate limitations. Impermeable rock. Locally fast drainage through fractures and sinks to water table. Possible groundwater contamination.	Severe to moderate limitations. Rock excavation possible.	Moderate to severe limitations. Rock excavation possible. Local drainage problems, especially on shale. Sinks possible. Avoid steep slopes.	Slight to severe, depending on topography. Rock excavation likely. Local drainage problems, especially on shale. Sinks possible.	Severe to slight limitations, depending on topography. Rock excavation. Sinks possible. Local drainage problems. Groundwater contamination possible.	Slight to moderate limitations. Rock excavation may be required.	Slight limitations, depending on activity and topography. Possible steep wooded slopes. No limitations for nature or forest preserve.	Slight to moderate limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Reservoir may leak where rocks are fractured. Sinks possible.	Moderate to severe limitations. Rock excavation likely.
7. Shale and limestone	Good to excellent foundation material; moderately difficult to difficult excavation.	Severe limitations. Impermeable rock.	Slight to moderate limitations. Earth and rock excavation. Poor drainage.	Slight to moderate limitations. Rock excavation. Local seeps; subgrade requires drainage.	Slight limitations. Local seeps.	Slight limitations. Rock generally rippable in shallow cuts. Local seeps.	No limitations.	No limitations.	Slight limitations. Most favorable sites are in this unit; locally, impermeable rock and underlain by fissured limestone.	Slight limitations.	Moderate limitations. Highly variable amount of rock and earth excavation.
8. Siltstone	Excellent foundation material; difficult to excavate.	Moderate limitations. Possible groundwater contamination.	Severe to moderate limitations. Rock excavation possible.	Slight to moderate limitations. Rock excavation.	Slight to moderate limitations. Rock excavation.	Moderate to slight limitations. Rock excavation.	No limitations.	Moderate to slight limitations. Rock excavation.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Moderate to slight limitations. Reservoir may leak where rocks are fractured.	Moderate limitations. Possible rock excavation.